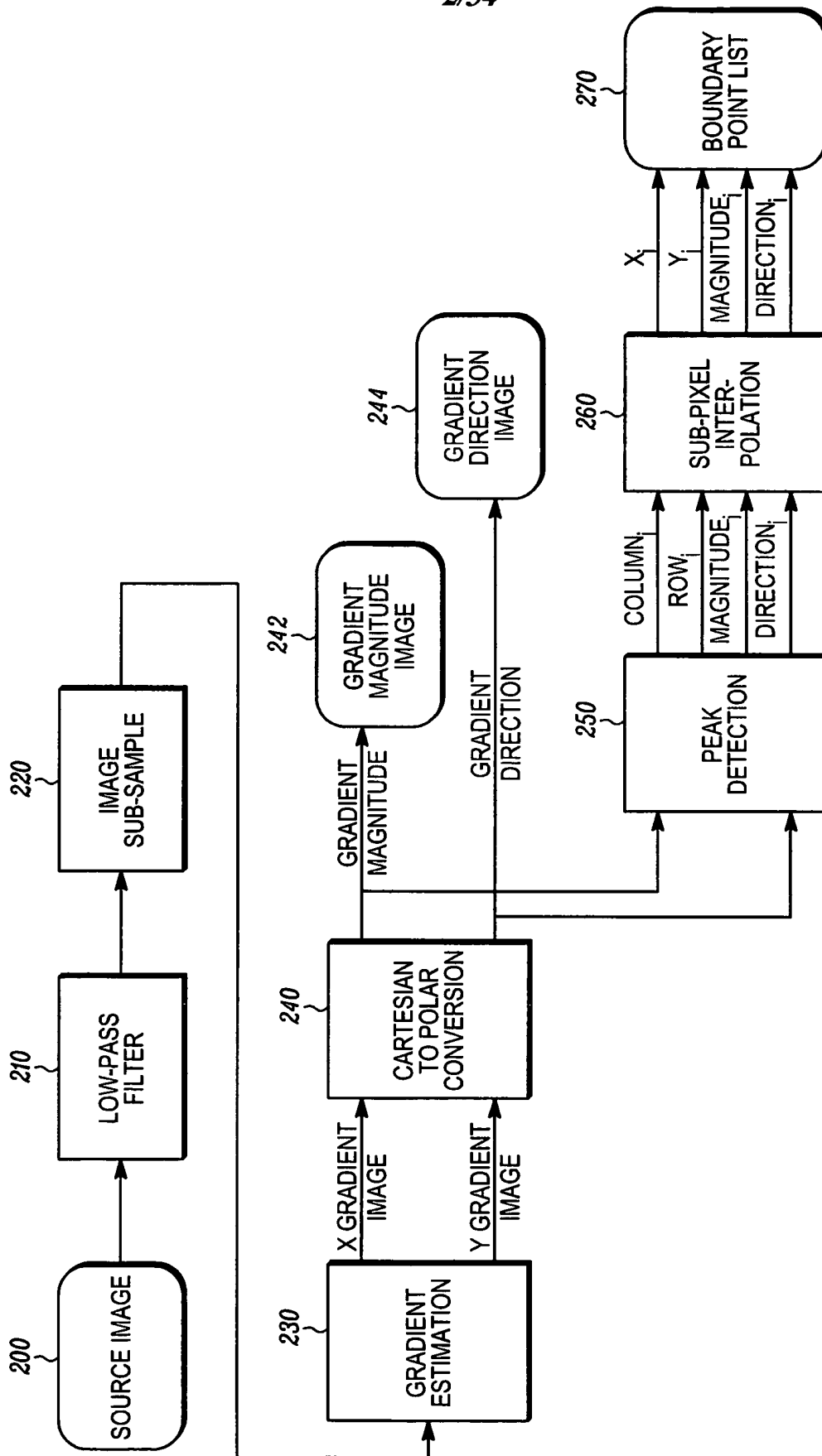


BLOCK DIAGRAM

FIG. 1



GRANULARITY CONTROL, GRADIENT, AND BOUNDARY DETECTION

FIG. 2

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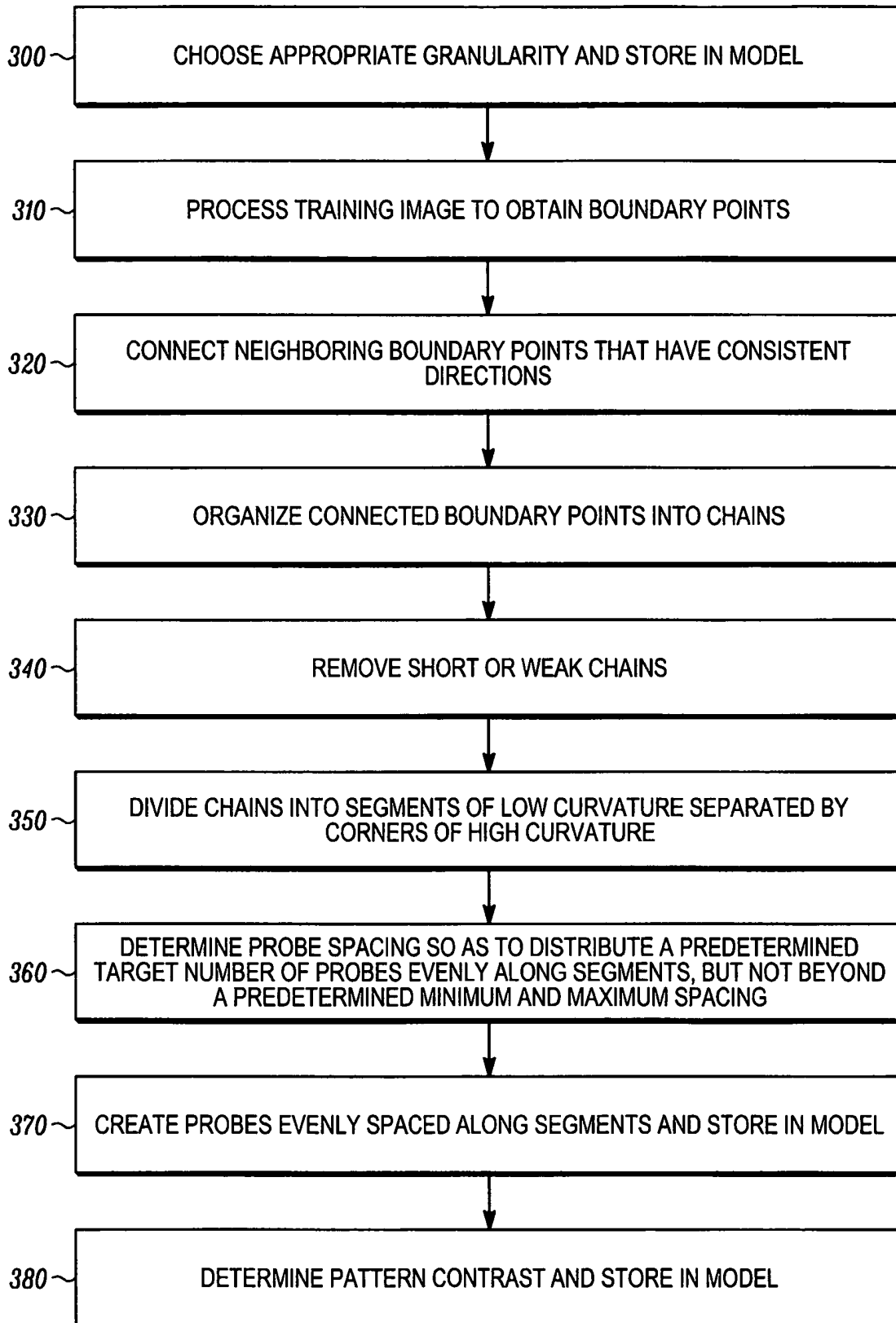
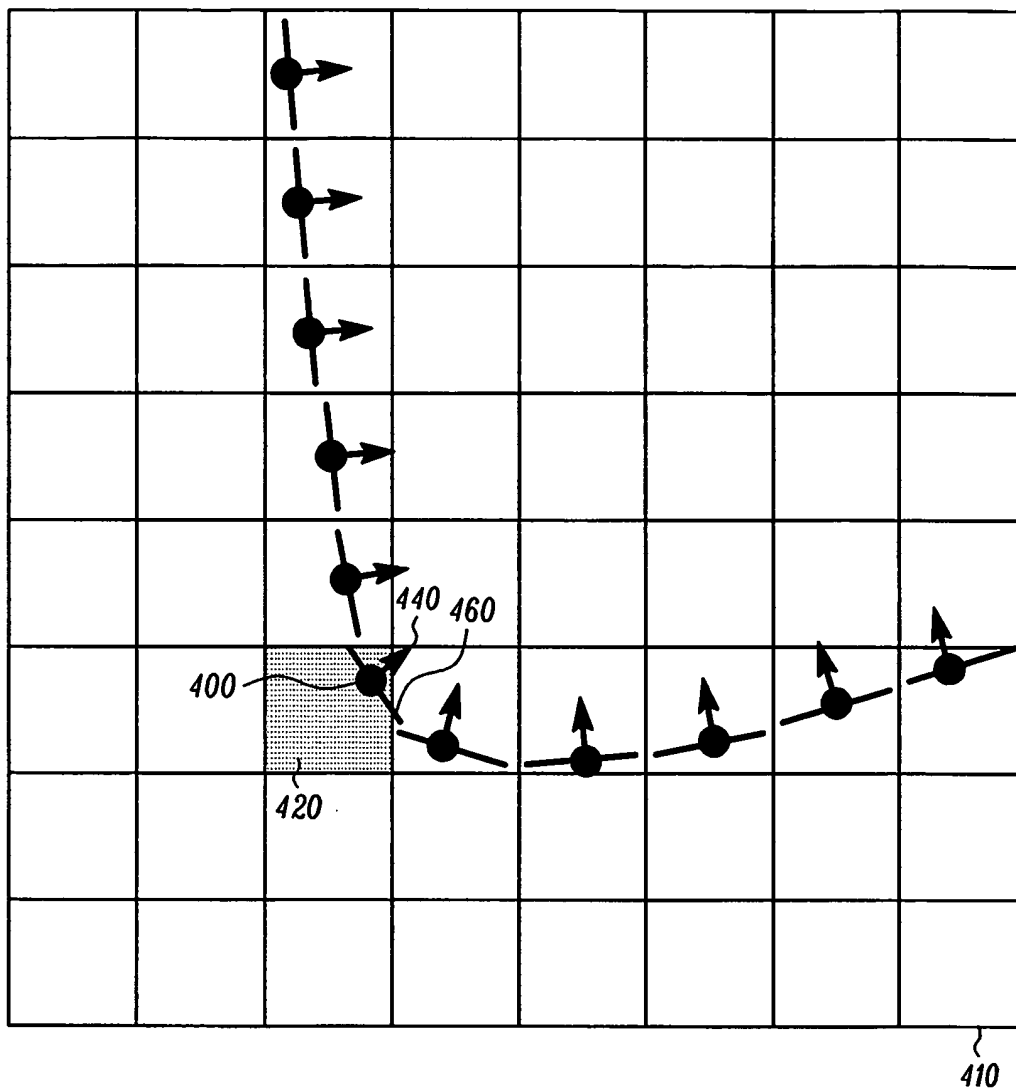


FIG. 3

TRAINING FLOW CHART



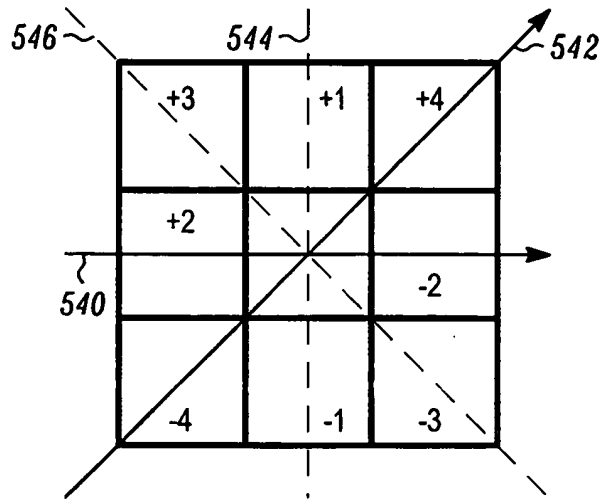
## BOUNDARY POINTS

*FIG. 4*



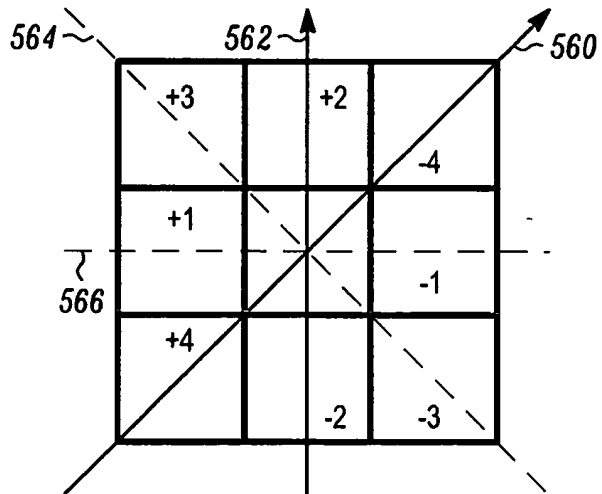
*FIG. 5A*

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NEIGHBOR ZONES 1

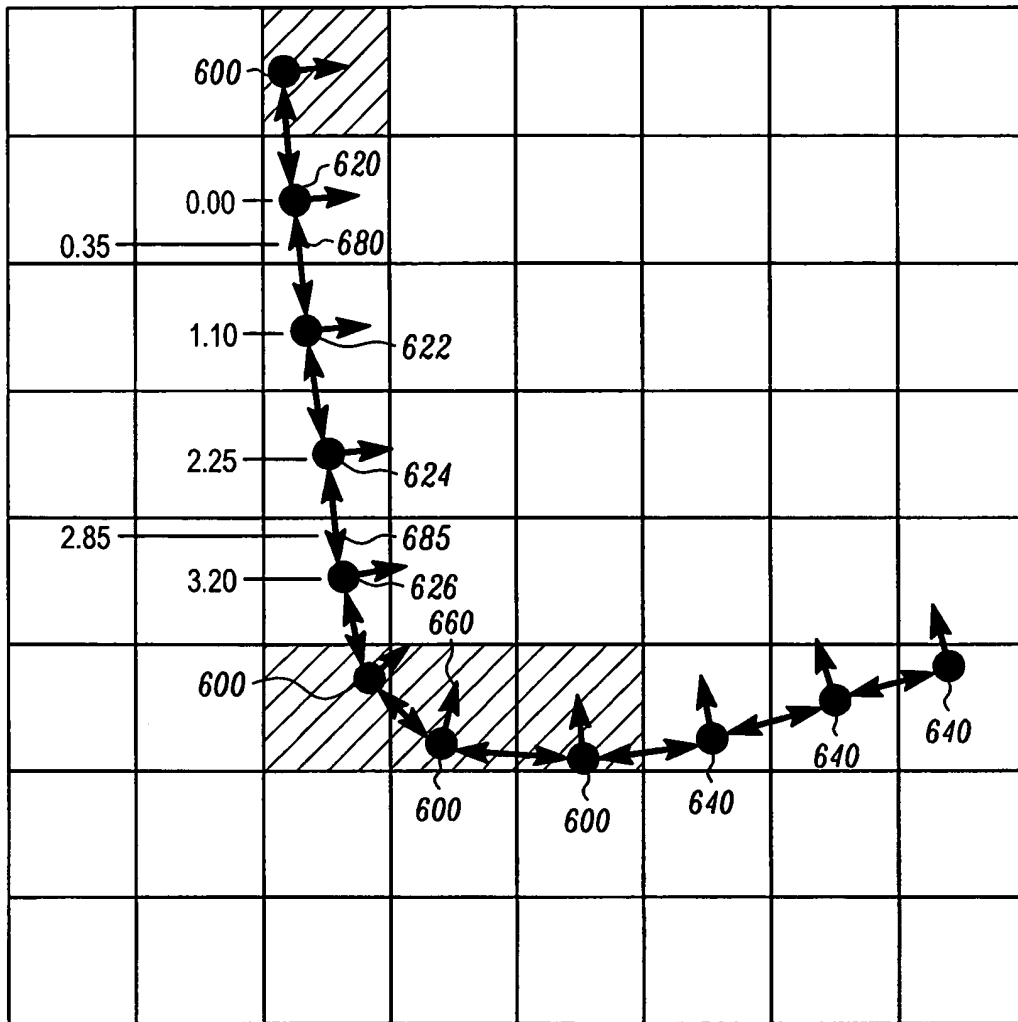
*FIG. 5B*



NEIGHBOR ZONES 2

*FIG. 5C*

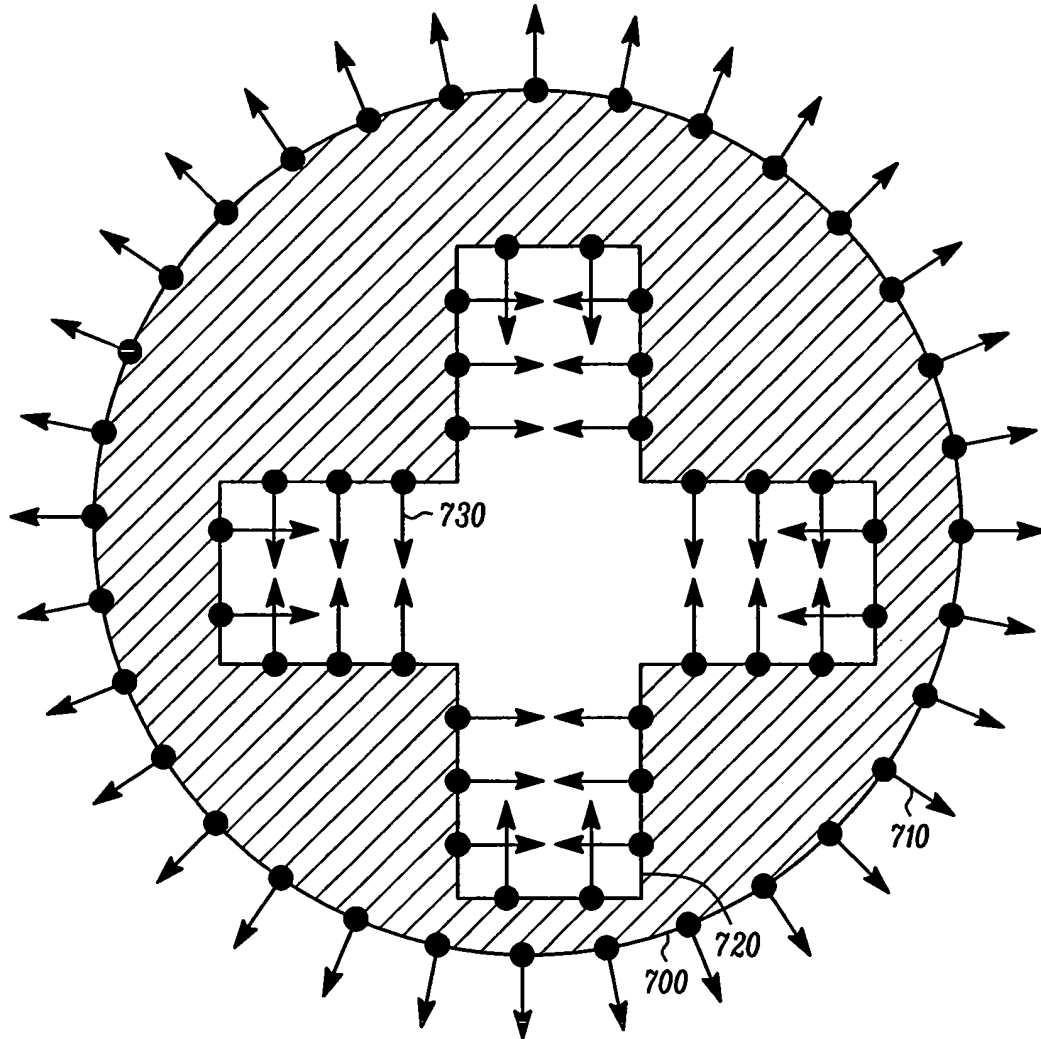
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CHAIN SEGMENTATION AND PROBE SELECTION

*FIG. 6*

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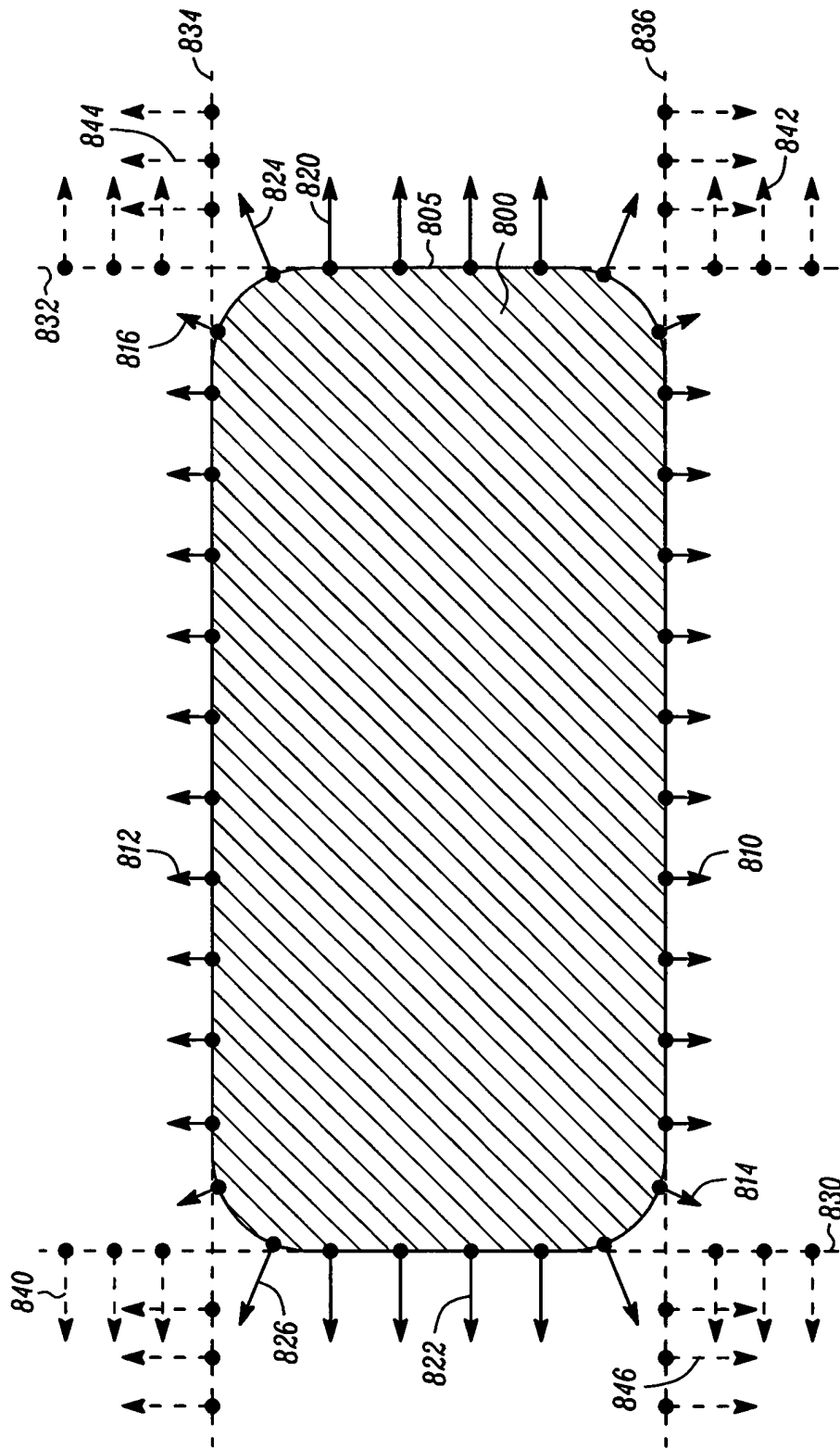


PROBE PLACEMENT

*FIG. 7*



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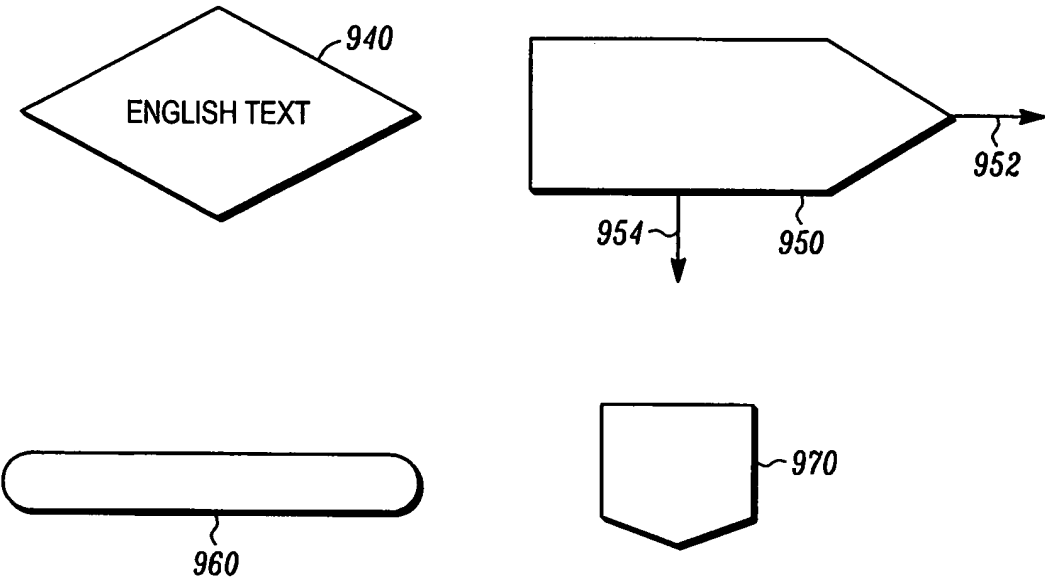


PROBE PLACEMENT FOR SYNTHETIC TRAINING OF ROUNDED RECTANGLE

FIG. 8

NAME-OF-SET OBJECT		
NAME	TYPE	NOTES
ELEMENT 1	TYPES OF ELEMENT 1	DESCRIPTION OF ELEMENT 1
ELEMENT 2	TYPES OF ELEMENT 2	DESCRIPTION OF ELEMENT 2

IDENTIFIERS, PSEUDO-CODE



TYPOGRAPHIC AND SYMBOLIC CONVENTIONS

FIG. 9

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MODEL OBJECT			
	NAME	TYPE	NOTES
1000	PROBES	LIST OF PROBE OBJECTS	PROBES CREATED BY TRAINING STEP 370
1010	GRANULARITY	REAL NUMBER	GRANULARITY CHOSEN DURING TRAINING STEP 300
1020	CONTRAST	REAL NUMBER	CONTRAST OF TRAINING PATTERN DETERMINED IN TRAINING STEP 380

MODEL

120

MODEL  
*FIG. 10*

PROBE OBJECT		
NAME	TYPE	NOTES
1100 POSITION	REAL 2-VECTOR	PROBE POSITION, PATTERN COORDS
1110 DIRECTION	BINARY ANGLE	EXPECTED GRADIENT DIRECTION, PATTERN COORDS
1120 WEIGHT	REAL NUMBER	PROBE WEIGHT, POSITIVE OR NEGATIVE

PROBE

1190

PROBE  
*FIG. 11A*

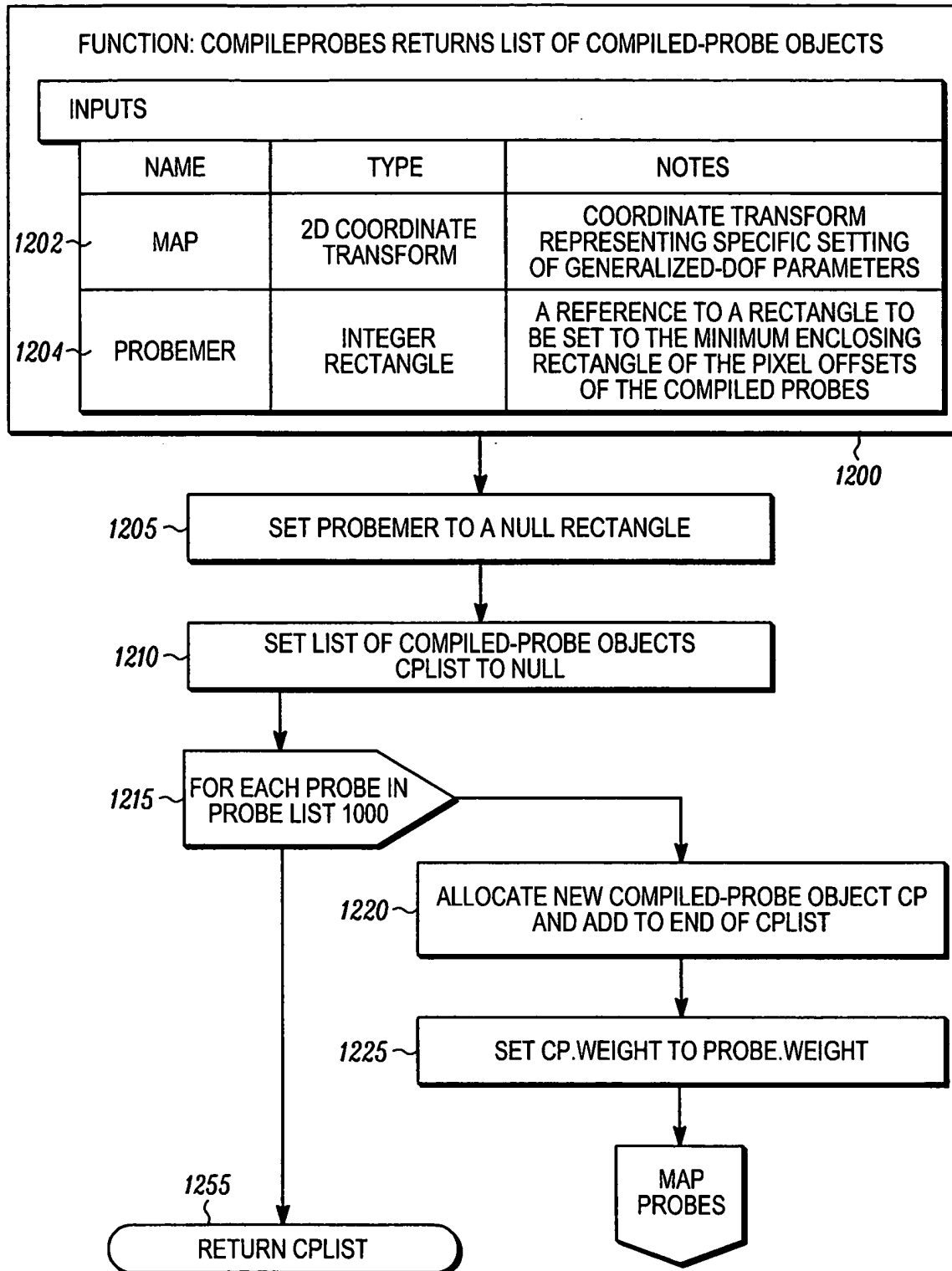
COMPILED-PROBE OBJECT		
NAME	TYPE	NOTES
1130 ~ OFFSET	INTEGER	MAPPED IMAGE PIXEL ADDRESS OFFSET
1140 ~ DIRECTION	BINARY ANGLE	MAPPED GRADIENT DIRECTION
1150 ~ WEIGHT	INTEGER	RELATIVE WEIGHT

COMPILED PROBE

1195

COMPILED PROBE  
*FIG. 11B*

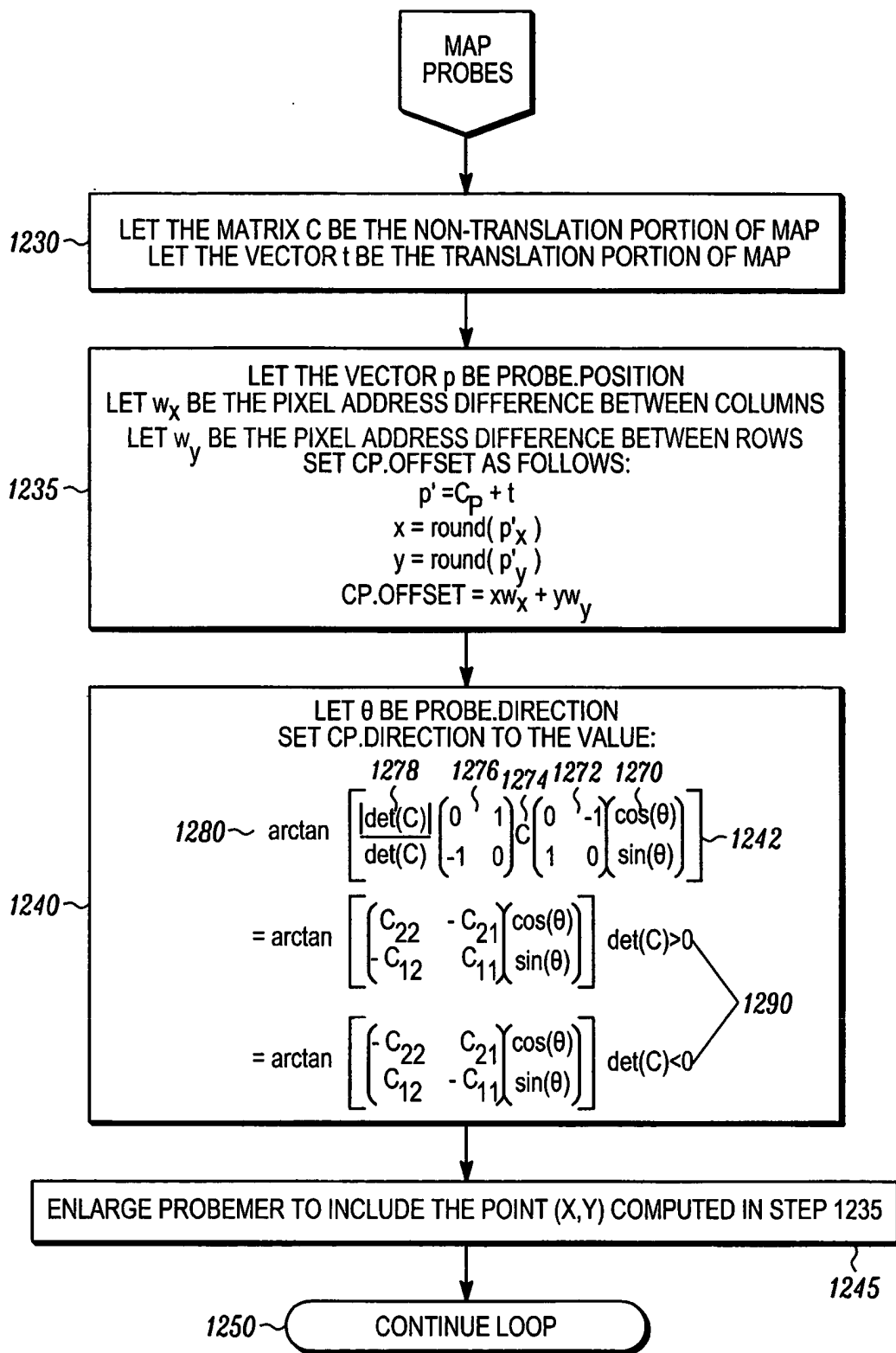
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PROBE COMPILER

FIG. 12A

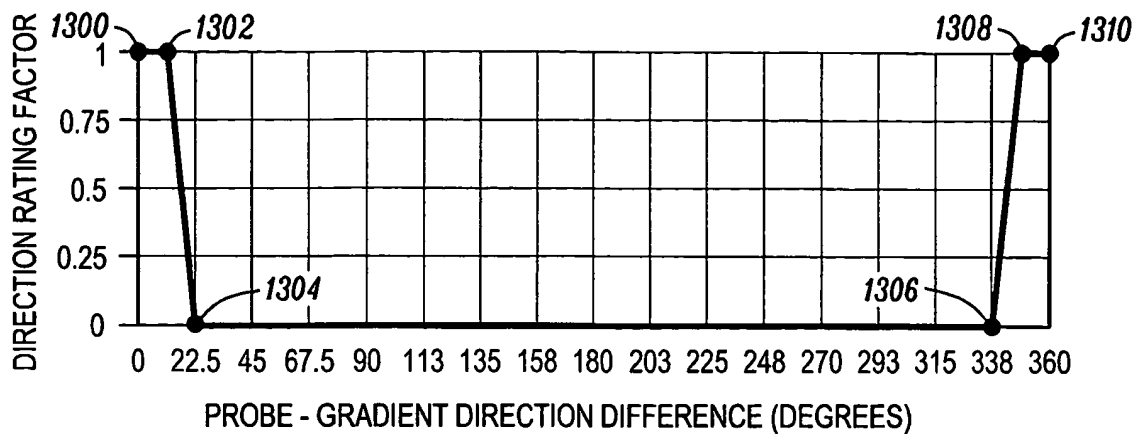
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PROBE COMPILER CONTINUED

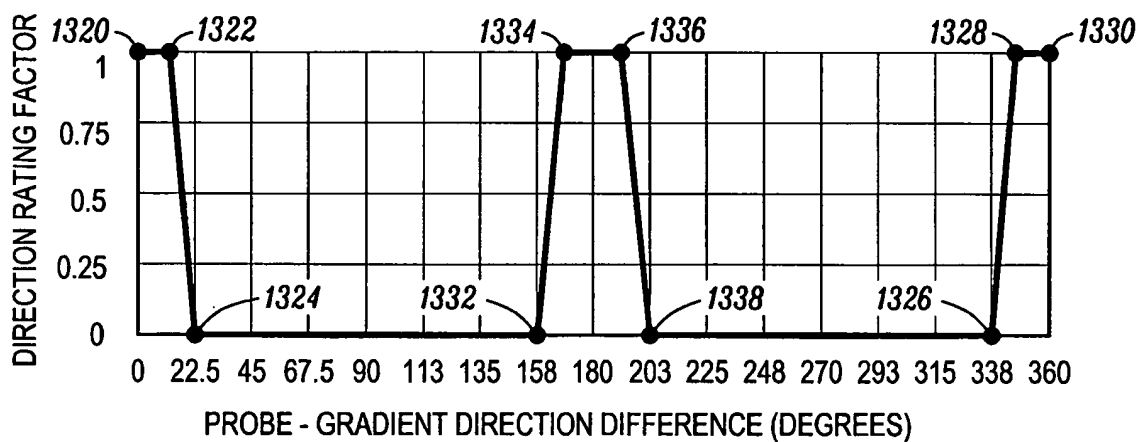
FIG. 12B

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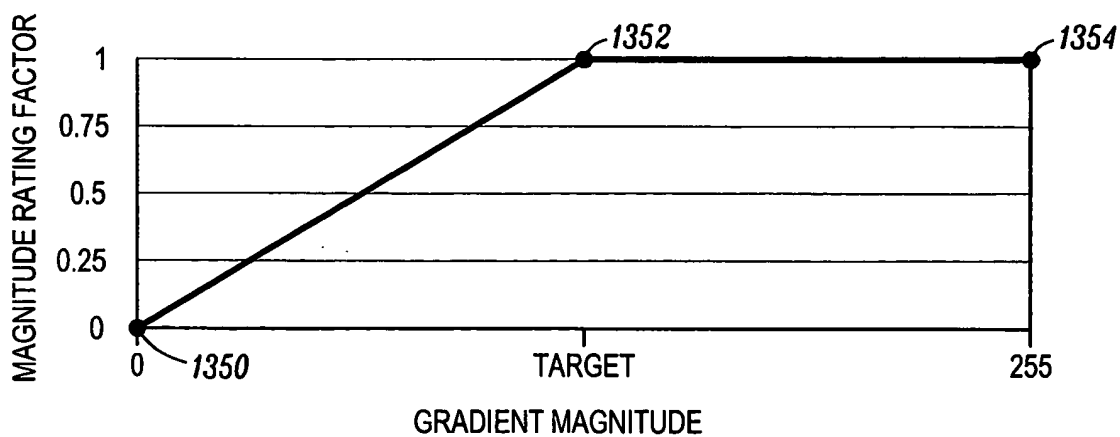
DIRECTION RATING FACTOR FUNCTION, CONSIDER POLARITY CASE

FIG. 13A



DIRECTION RATING FACTOR FUNCTION, IGNORE POLARITY CASE

FIG. 13B



MAGNITUDE RATING FACTOR FUNCTION

FIG. 13C

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GENERALIZED-DOF OBJECT			
	NAME	TYPES	NOTES
1400~	LOW	REAL NUMBER	REQUESTED LOW END OF SEARCH RANGE
1405~	HIGH	REAL NUMBER	REQUESTED HIGH END OF SEARCH RANGE
1410~	MAXSTEPSIZE	REAL NUMBER	MAXIMUM STEP SIZE
1415~	DUPRANGE	REAL NUMBER	DUPLICATE DETECTION RANGE
1420~	START	REAL NUMBER	ACTUAL LOW END OF SEARCH RANGE
1430~	NUMCOARSESTEPS	INTEGER	NUMBER OF COARSE STEPS FROM START TO STOP
1435~	STEPSIZE	REAL NUMBER	ACTUAL STEP SIZE, DERIVED FROM MAXSTEPSIZE AND PARAMETER RANGE
1440~	CYCLE	REAL NUMBER	IF DOF IS CYCLIC VALUE FOR ONE CYCLE; ELSE 0
1445~	MAPPER	2D-COORDINATE-TRANSFORM-VALUED FUNCTION OF REAL ARGUMENT	CONVERT DOF PARAMETER TO CORRESPONDING TRANSFORM
1450~	STEPSIZEMATRIX	2 X 2-MATRIX	MATRIX FOR COMPUTING MAX STEP SIZE
1455~	STEPSIZEFACTOR	REAL NUMBER	CONVERSION FACTOR FOR COMPUTING MAX STEP SIZE
1460~	SCALEFACTOR	REAL-VALUED FUNCTION	"AVERAGE" SCALE FACTOR BASED ON SETTINGS OF LOW AND HIGH

1490

GENERALIZED-DOF

FIG. 14

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		1500	1440	1445	1450	1455	1460
		PARAMETER	CYCLE	MAPPER (X)	STEPSIZEMATRIX	STEPSIZEFACTOR	SCALEFACTOR ( )
1540	ROTATION	ANGLE, DEGREES	360	$\begin{pmatrix} \cos(x) & -\sin(x) \\ \sin(x) & \cos(x) \end{pmatrix}$	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	180/π	1
1545	SHEAR	ANGLE, DEGREES	360	$\begin{pmatrix} 1 & -\tan(x) \\ 0 & 1 \end{pmatrix}$	$\begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix}$	180/π	1
1550	LOG SIZE	LOG SCALE FACTOR	0	$\begin{pmatrix} e^x & 0 \\ 0 & e^x \end{pmatrix}$	$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$	1	$\frac{LOW+HIGH}{e^2}$
1555	LOG x SIZE	LOG SCALE FACTOR	0	$\begin{pmatrix} e^x & 0 \\ 0 & 1 \end{pmatrix}$	$\begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}$	1	$\frac{LOW+HIGH}{e^4}$
1560	LOG y SIZE	LOG SCALE FACTOR	0	$\begin{pmatrix} 1 & 0 \\ 0 & e^x \end{pmatrix}$	$\begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix}$	1	$\frac{LOW+HIGH}{e^4}$
1565	LOG ASPECT	LOG RATIO y TO x SCALE FACTOR	0	$\begin{pmatrix} e^{-x/2} & 0 \\ 0 & e^{x/2} \end{pmatrix}$	$\begin{pmatrix} 1/2 & 0 \\ 0 & -1/2 \end{pmatrix}$	1	1
1570	SIZE	SCALE FACTOR	0	$\begin{pmatrix} x & 0 \\ 0 & x \end{pmatrix}$	$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$	1	$\sqrt{LOW \cdot HIGH}$
1575	x SIZE	SCALE FACTOR	0	$\begin{pmatrix} x & 0 \\ 0 & 1 \end{pmatrix}$	$\begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}$	1	$\sqrt[4]{LOW \cdot HIGH}$
1580	y SIZE	SCALE FACTOR	0	$\begin{pmatrix} 1 & 0 \\ 0 & x \end{pmatrix}$	$\begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix}$	1	$\sqrt[4]{LOW \cdot HIGH}$
1585	ASPECT	RATIO y TO x SCALE FACTOR	0	$\begin{pmatrix} x^{-1/2} & 0 \\ 0 & x^{1/2} \end{pmatrix}$	$\begin{pmatrix} 1/2 & 0 \\ 0 & -1/2 \end{pmatrix}$	1	1

FIG. 15 DATA FOR SPECIFIC GENERALIZED-DOFS



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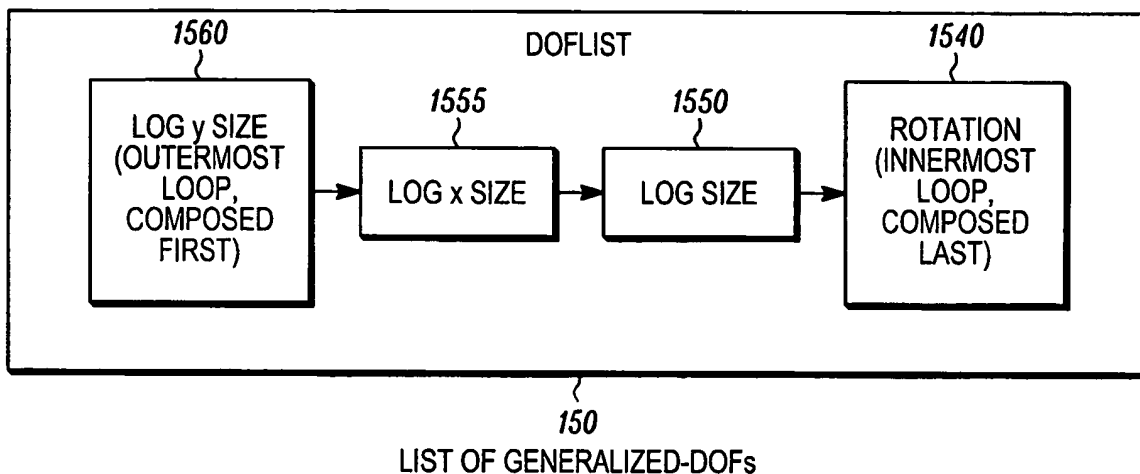


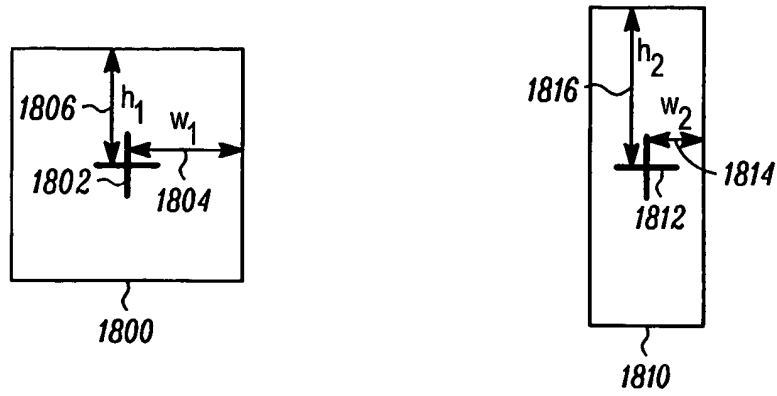
FIG. 16

RESULT OBJECT			
	NAME	TYPE	NOTES
1700~	POSITION	REAL 2-VECTOR	PROBE ORIGIN AT MATCH POSITION, IMAGE COORDS
1710~	PROBEMER	REAL RECTANGLE	MIN. ENCLOSING RECTANGLE OF PROBES AT MATCH POSITION, IMAGE COORDS
1720~	SCORE	REAL NUMBER	MATCH SCORE
1730~	CONTRAST	REAL NUMBER	WEIGHTED MEDIAN GRADIENT MAGNITUDE UNDER POSITIVE PROBES
1740~	DOFPARAMETERS	LIST OF REAL NUMBERS	DOF PARAMETERS AT MATCH POSE
1750~	DOFINDICES	LIST OF INTEGERS	DOF STEP INDICES AT MATCH POSE
1760~	PROBERATINGS	LIST OF REAL NUMBERS	LIST OF INDIVIDUAL PROBE RATINGS $R_{mag} * R_{dir}$ FROM THIRD MATCH FUNCTION $S_3$

RESULT

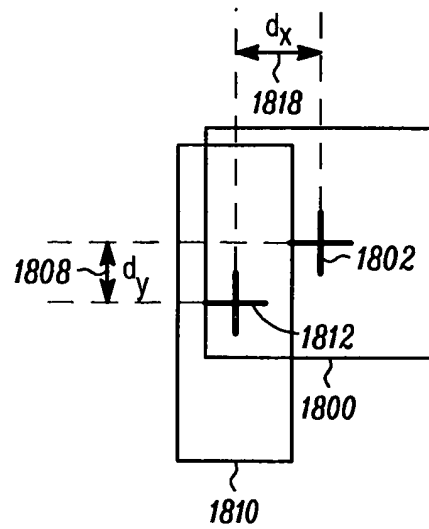
FIG. 17

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OVERLAP CALCULATION

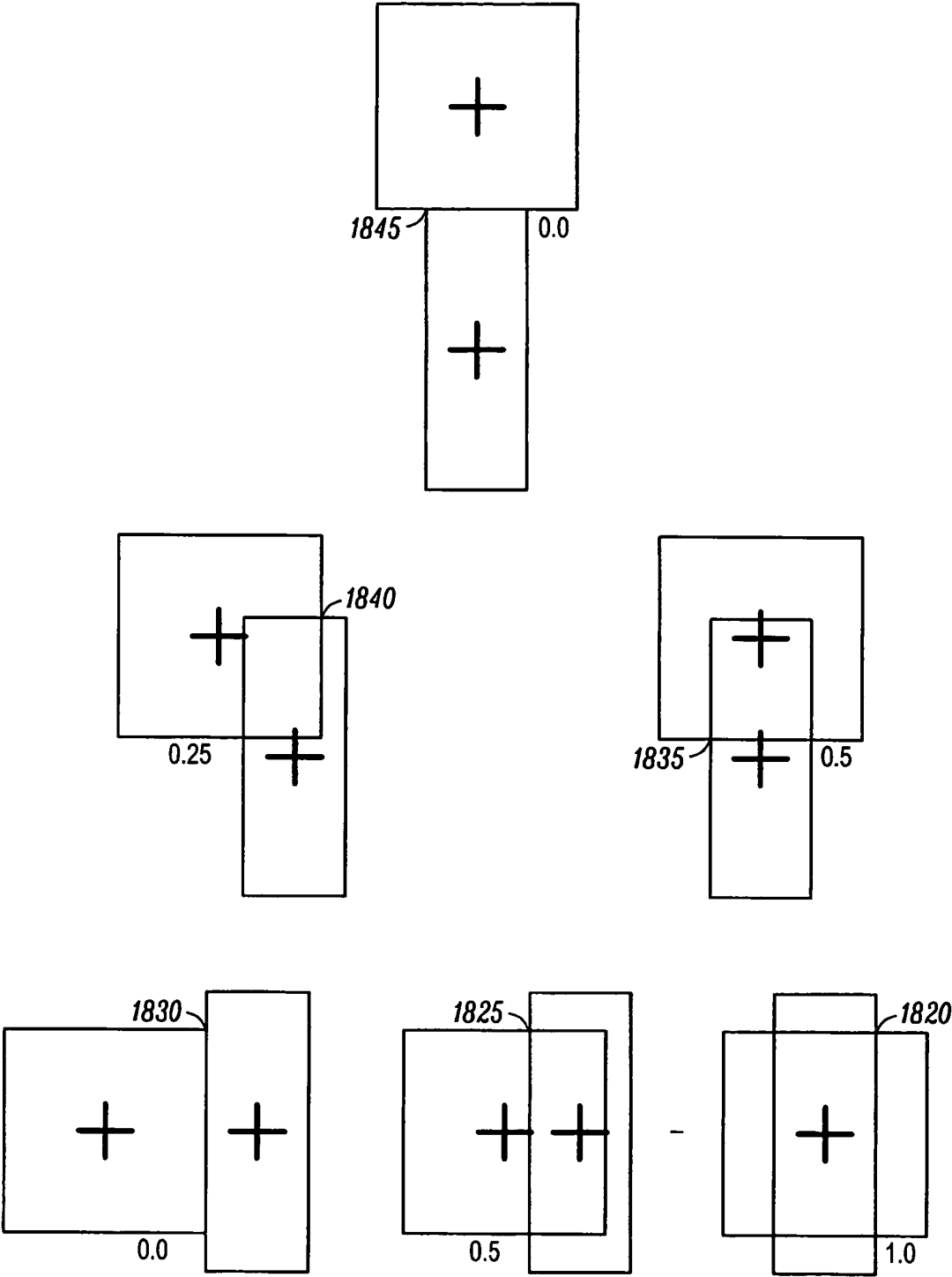
*FIG. 18A*



OVERLAP CALCULATION

*FIG. 18B*

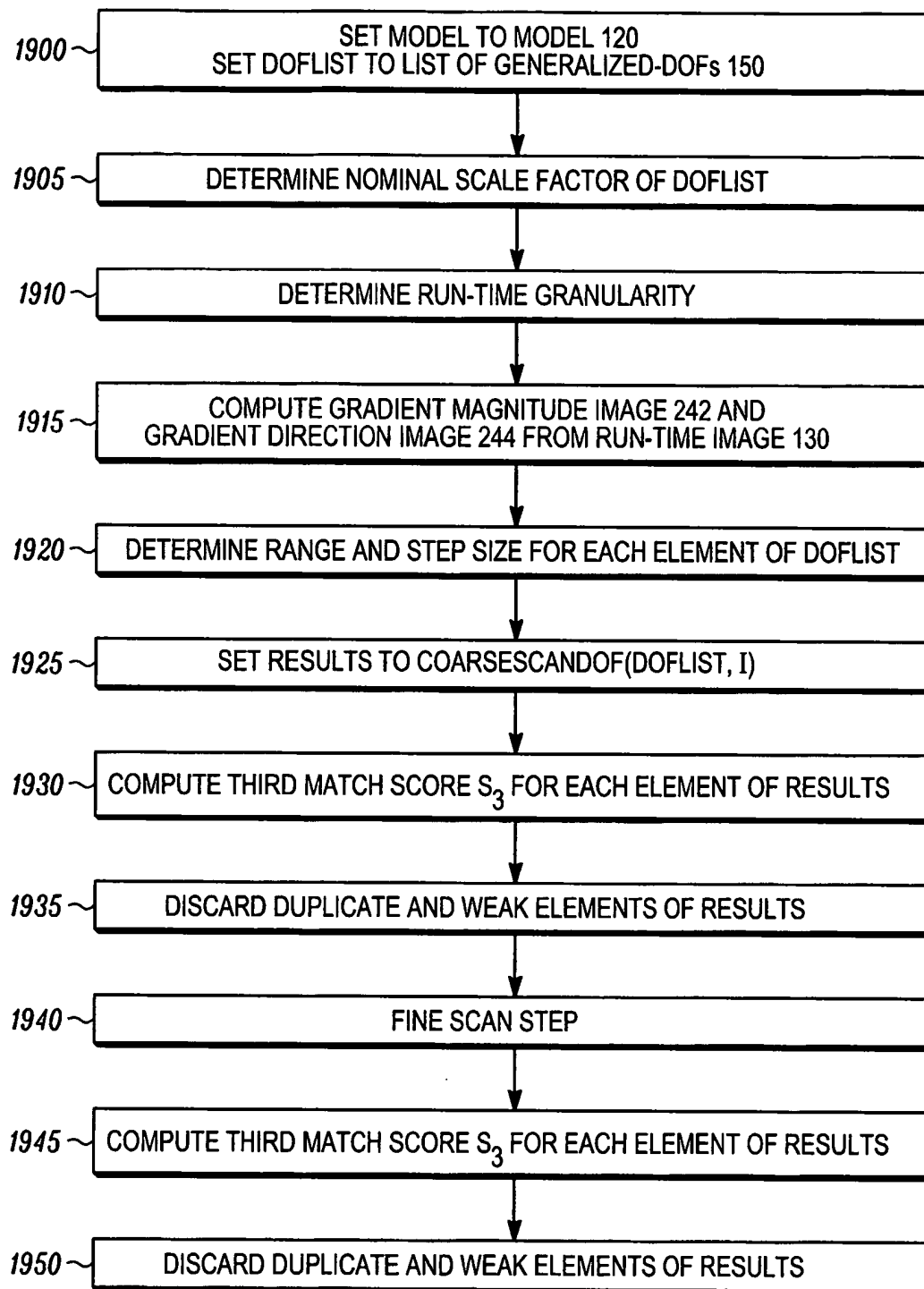
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OVERLAP EXAMPLES

FIG. 18C

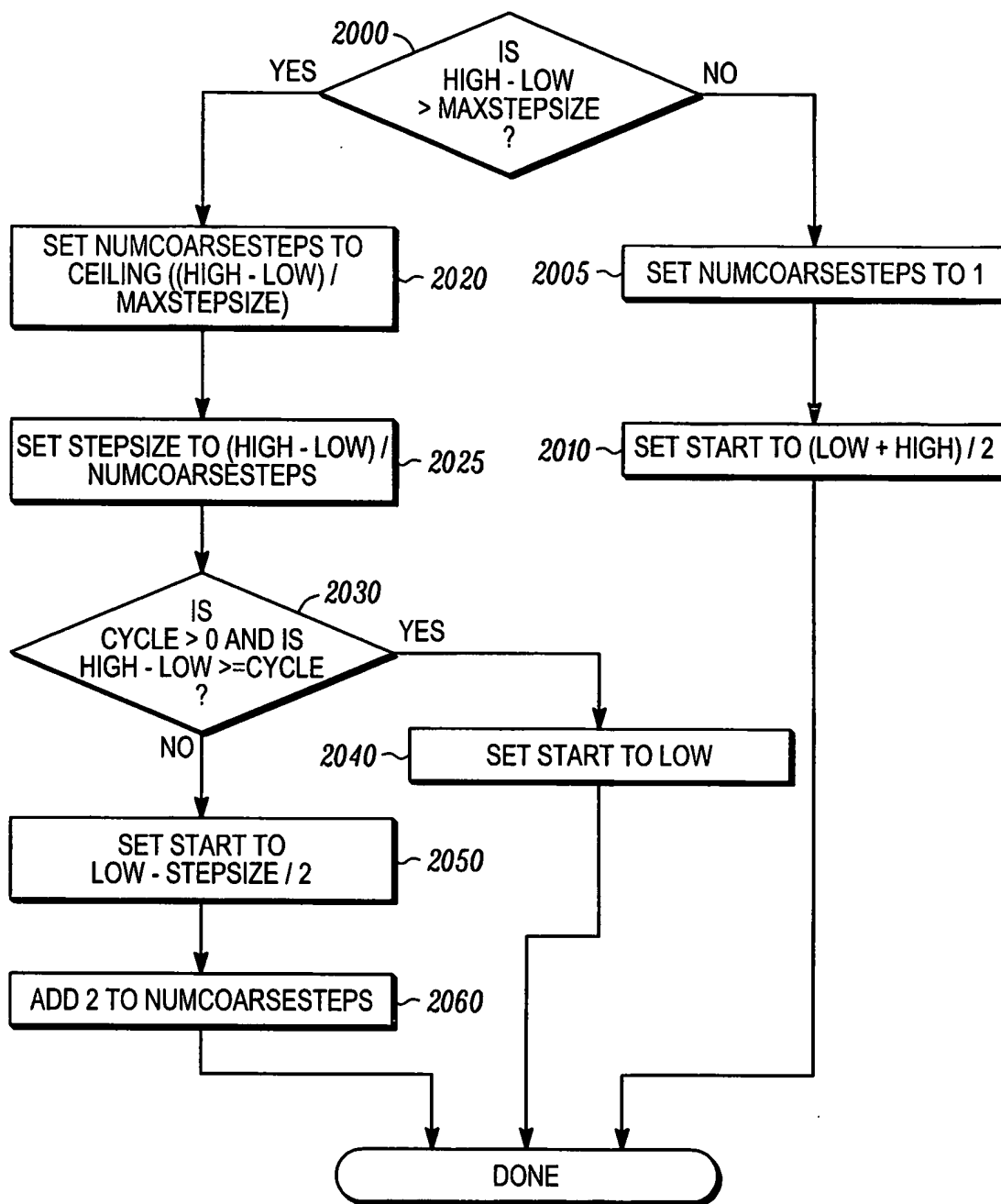
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FLOW CHART OF RUN-TIME STEP 140

FIG. 19

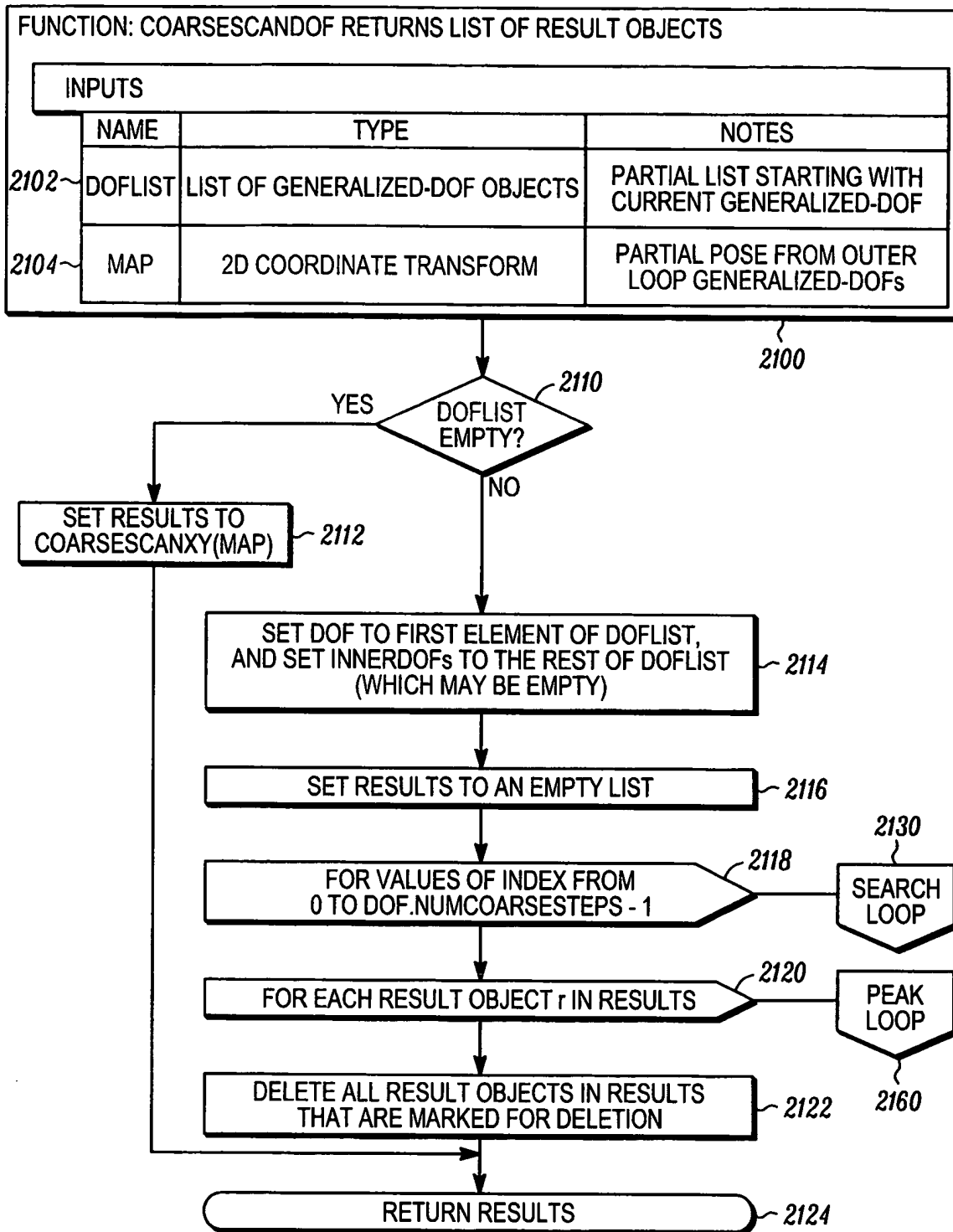
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FLOW CHART OF PORTION OF STEP 1920

FIG. 20

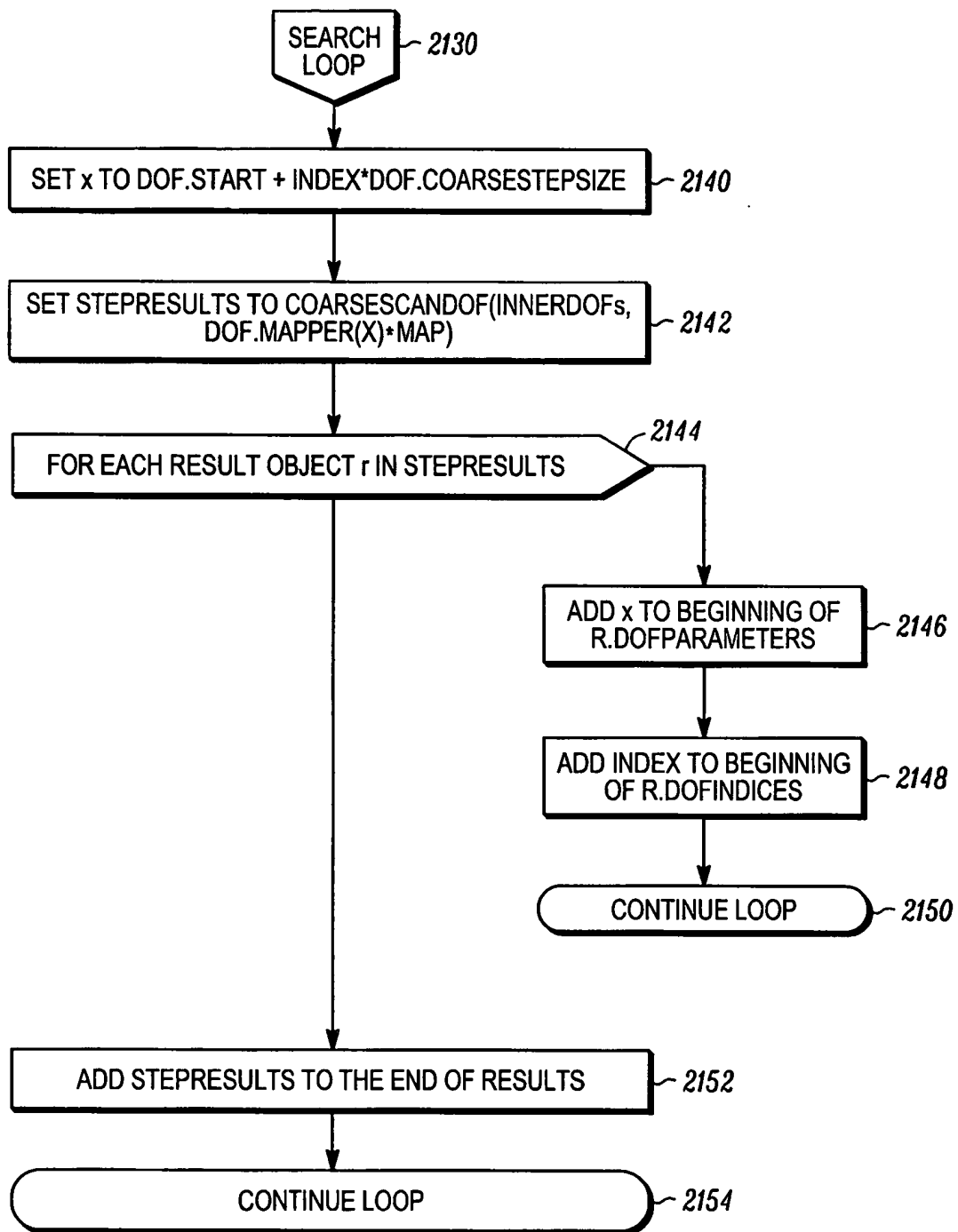
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COARSE SCAN GENERALIZED-DOF

FIG. 21A

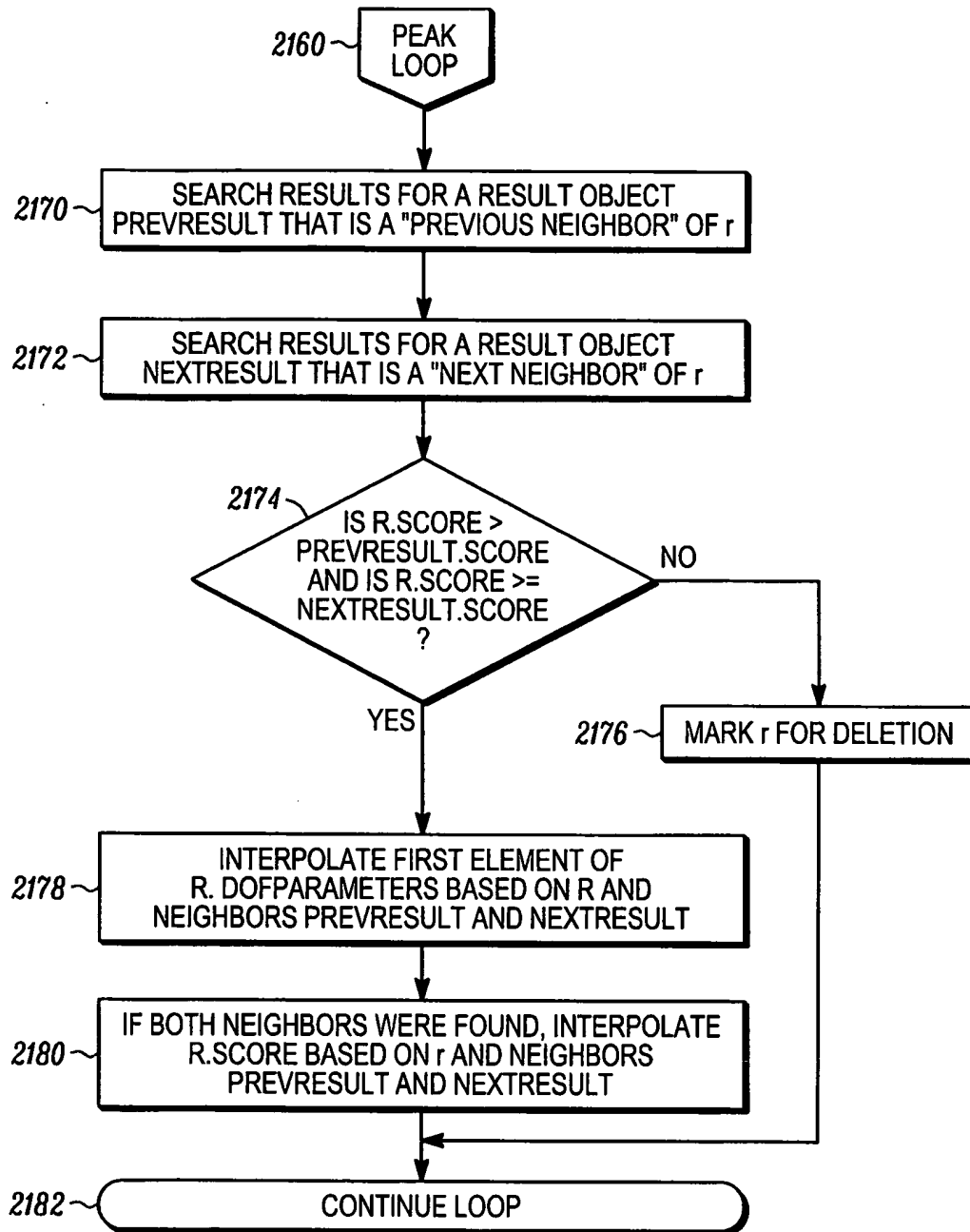
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COARSE SCAN GENERALIZED-DOF CONTINUED

FIG. 21B

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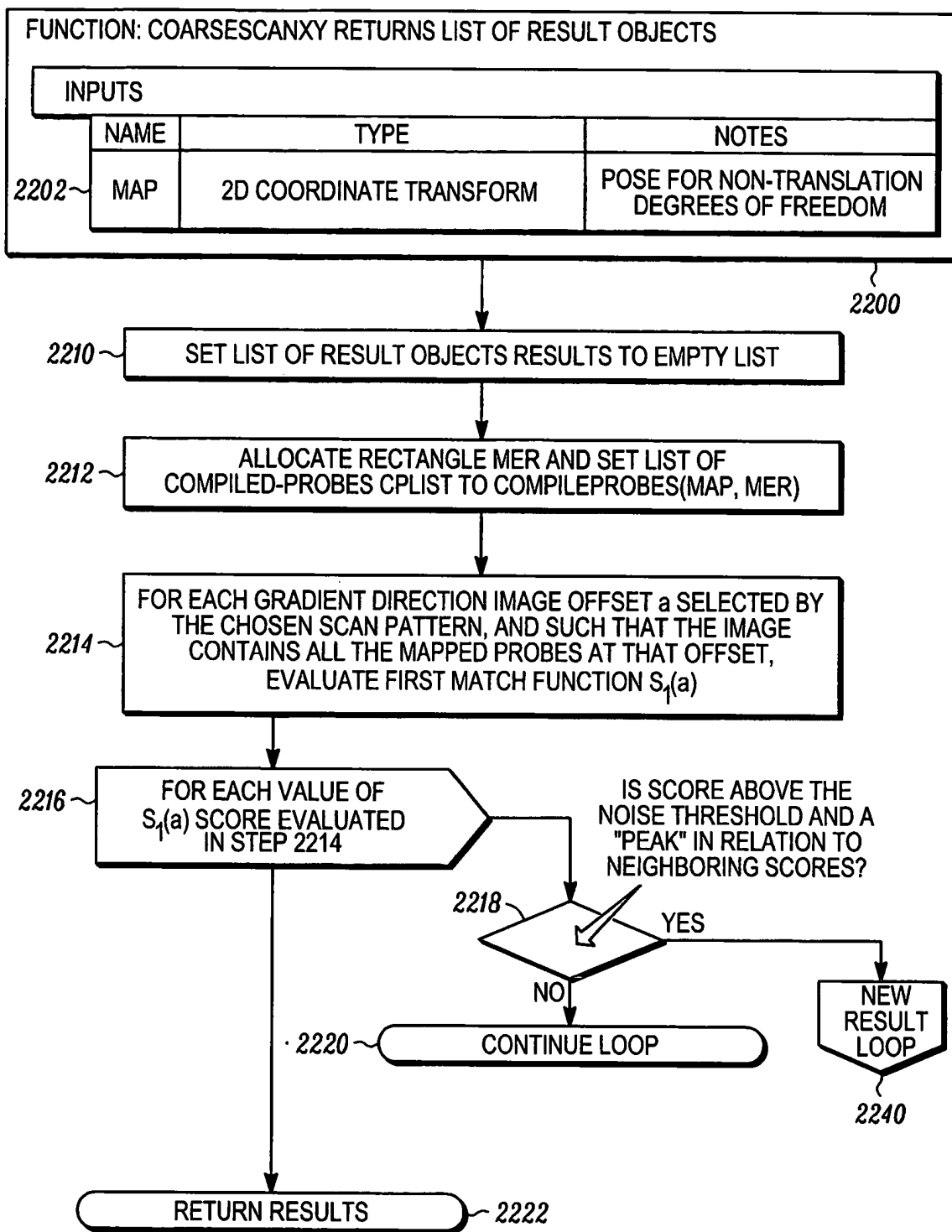


COARSE SCAN GENERALIZED-DOF CONTINUED

FIG. 21C



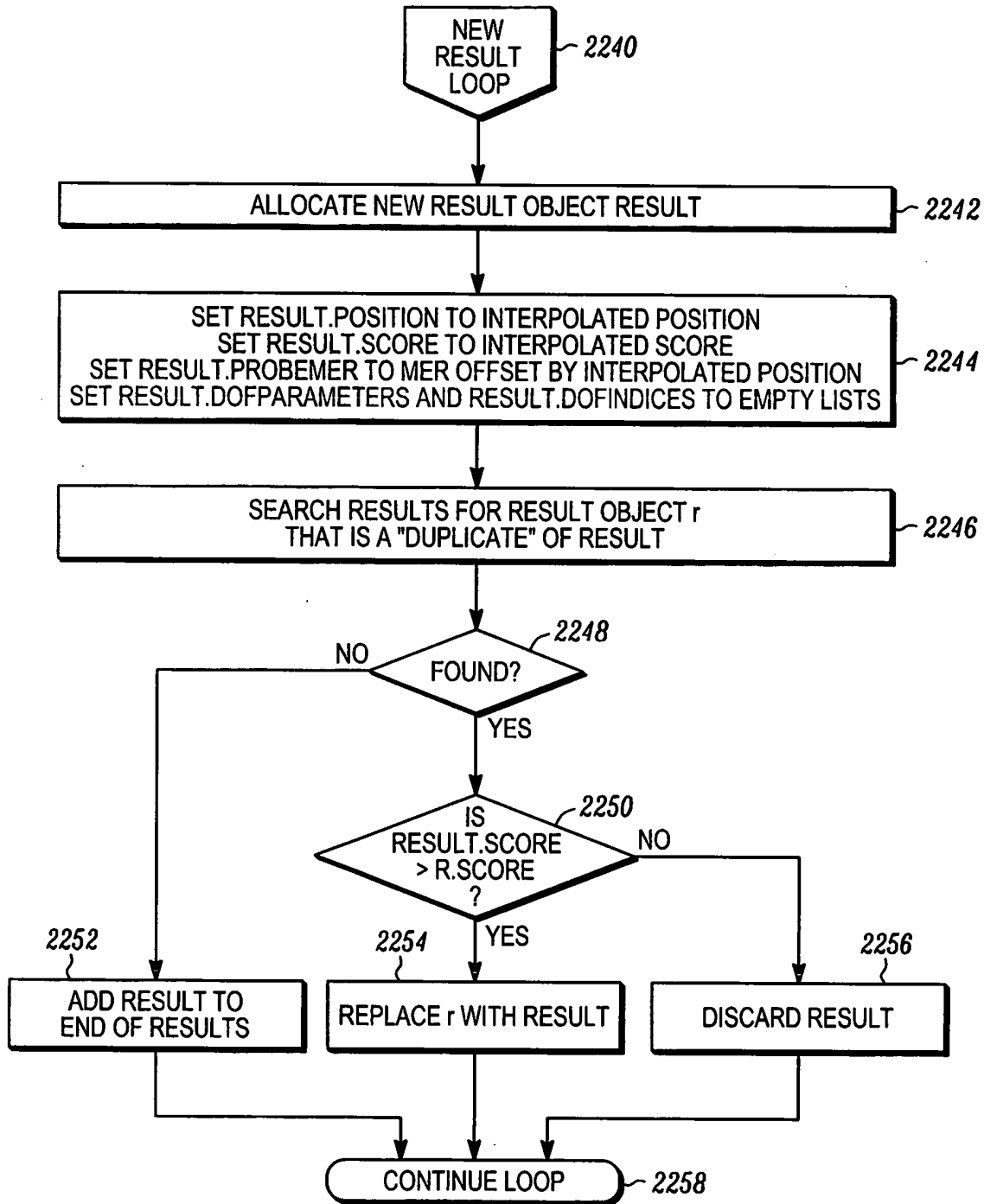
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COARSE SCAN X - Y POSITION

FIG. 22A

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COARSE SCAN X - Y POSITION CONTINUED

*FIG. 22B*

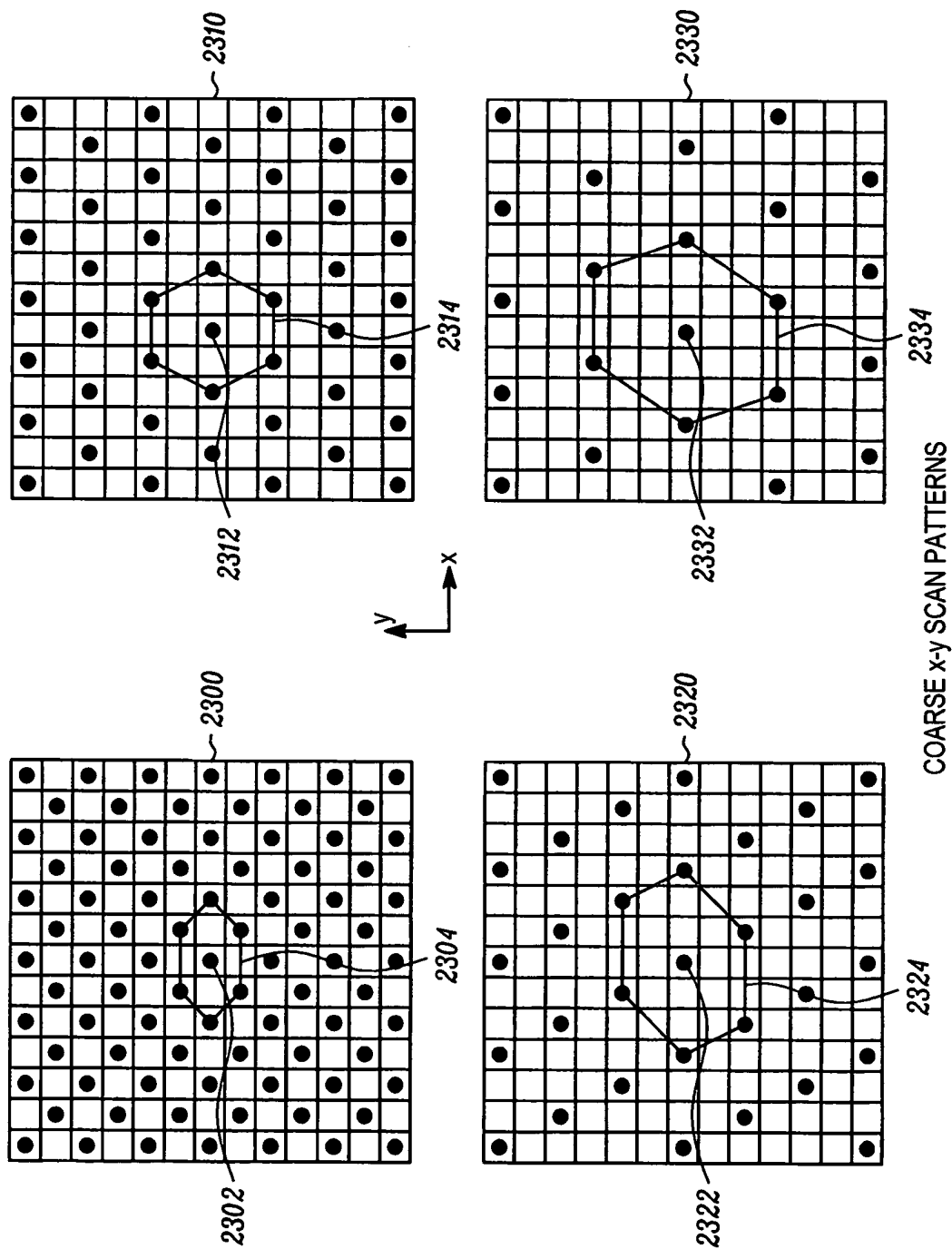
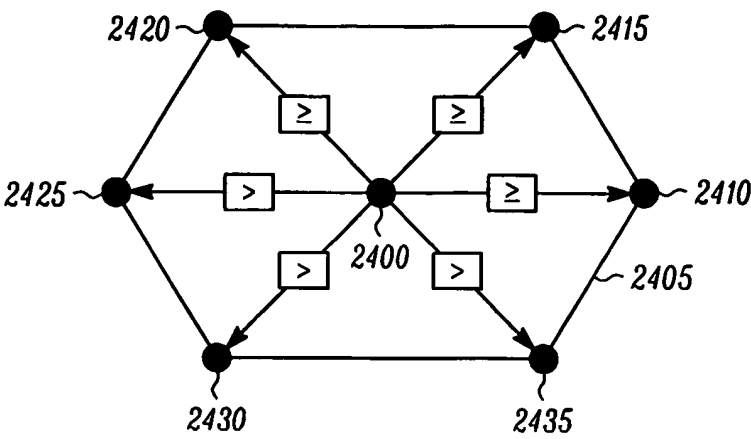
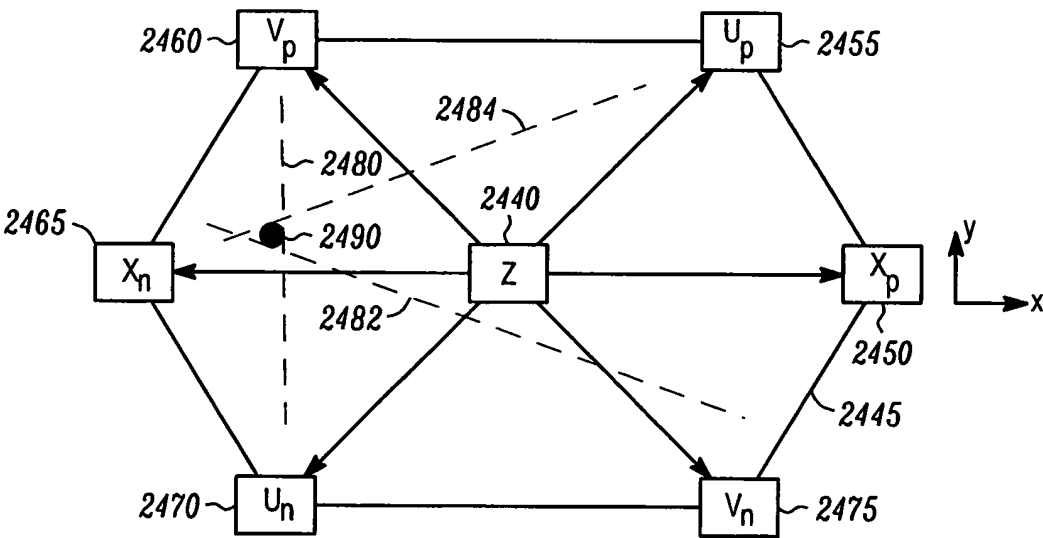


FIG. 23



HEXAGONAL PEAK DETECTION

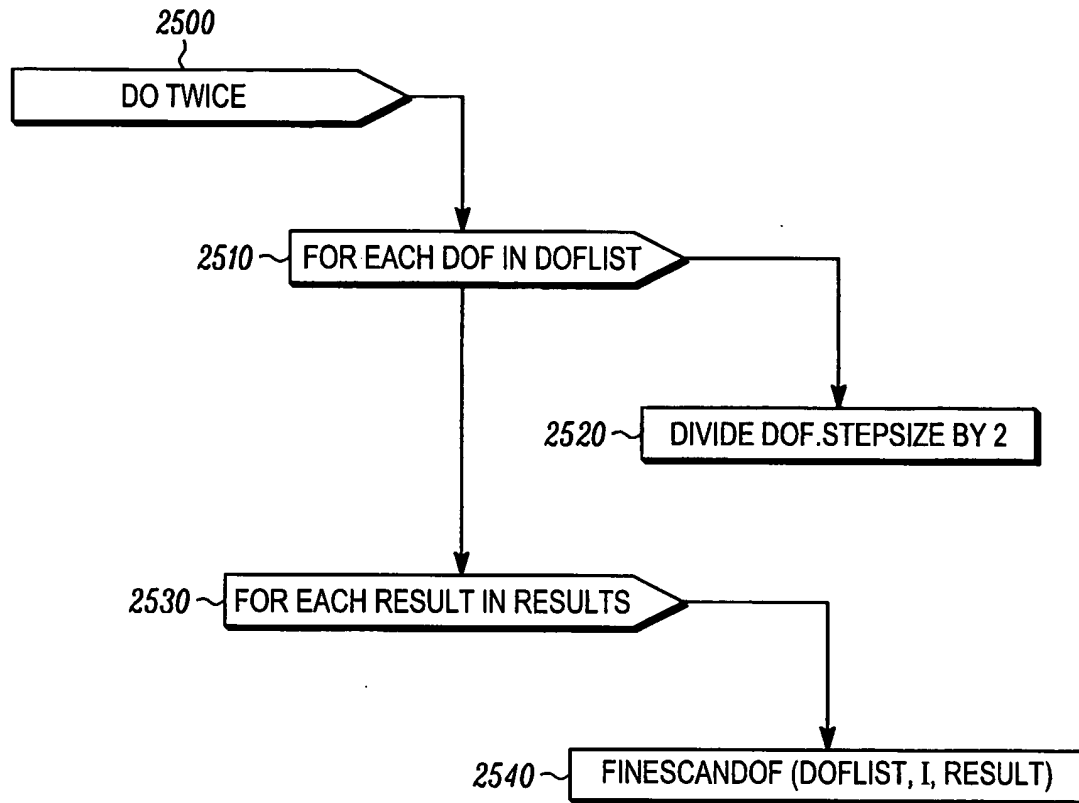
FIG. 24A



HEXAGONAL INTERPOLATION

FIG. 24B

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FINE SCAN STEP 1940

*FIG. 25*

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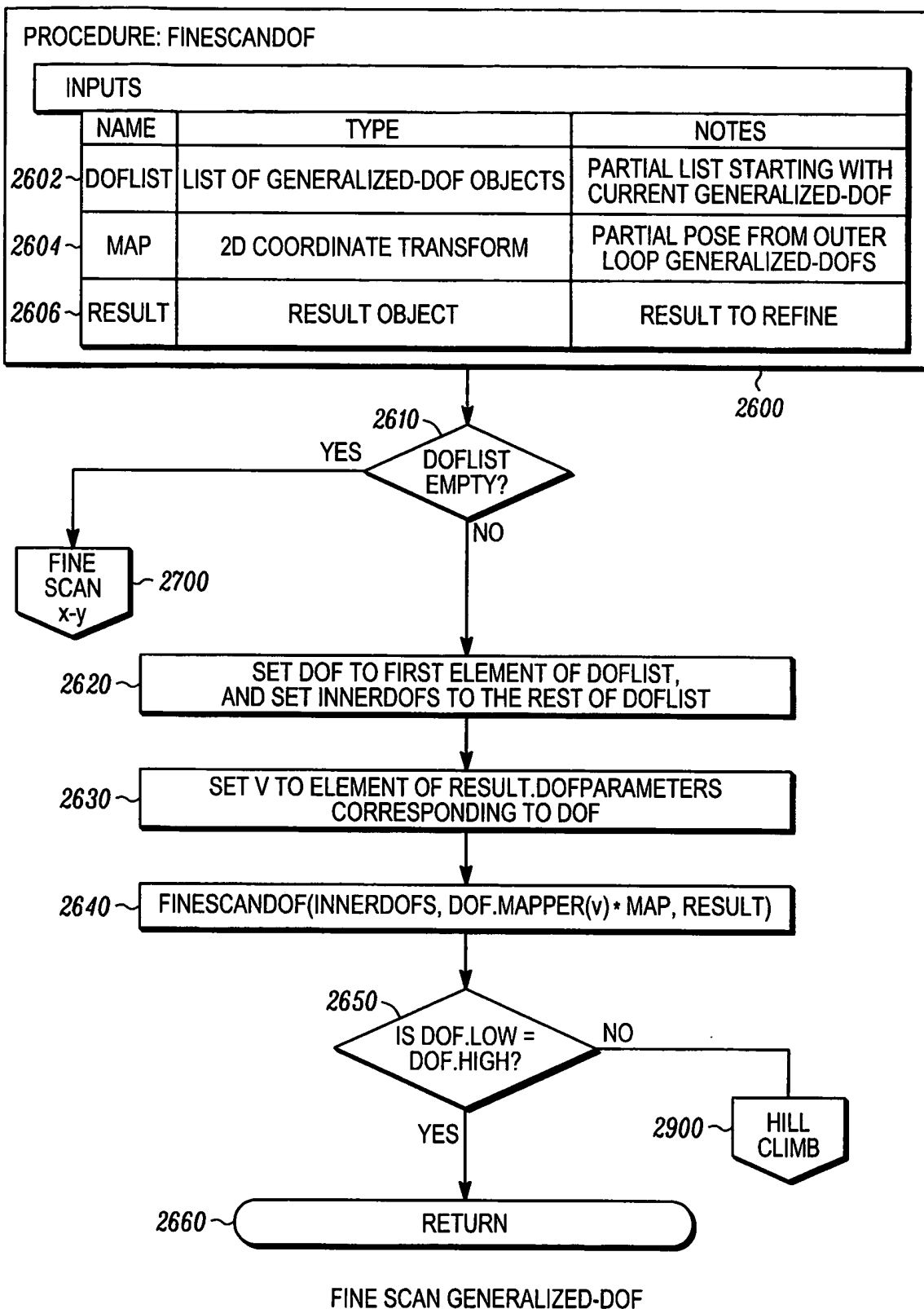
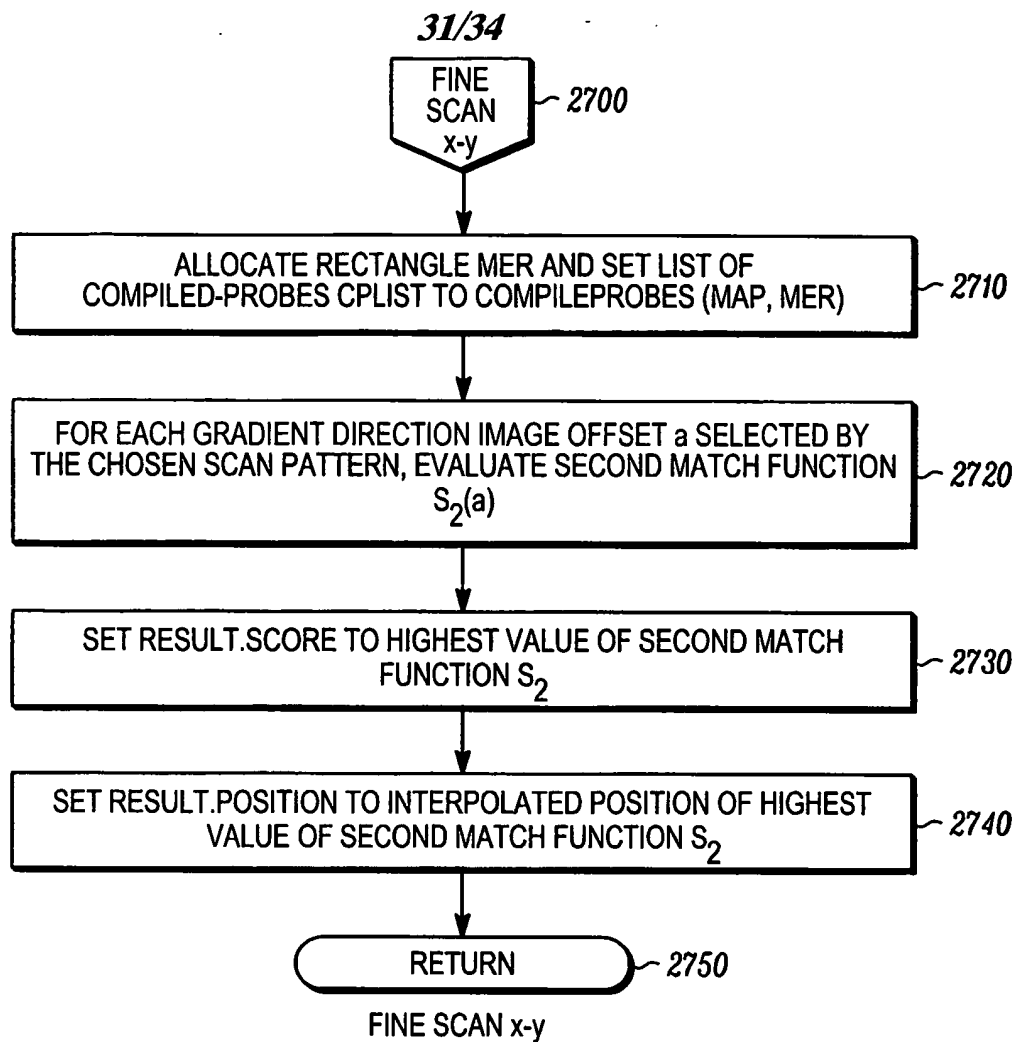
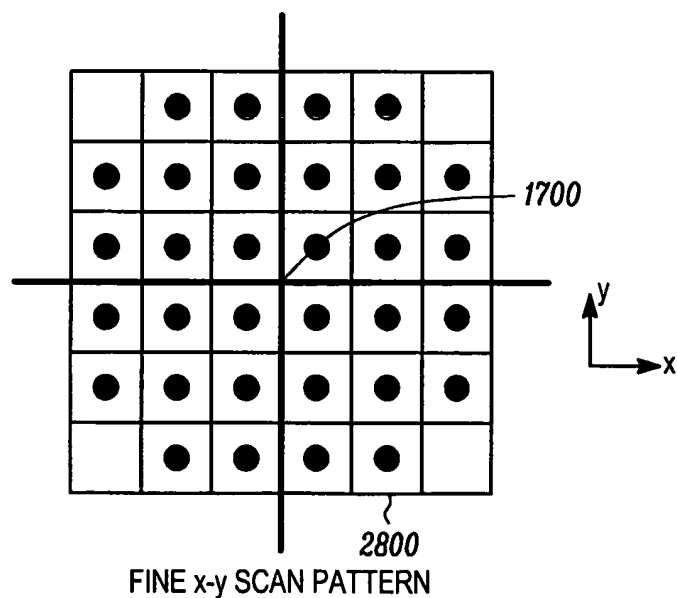


FIG. 26

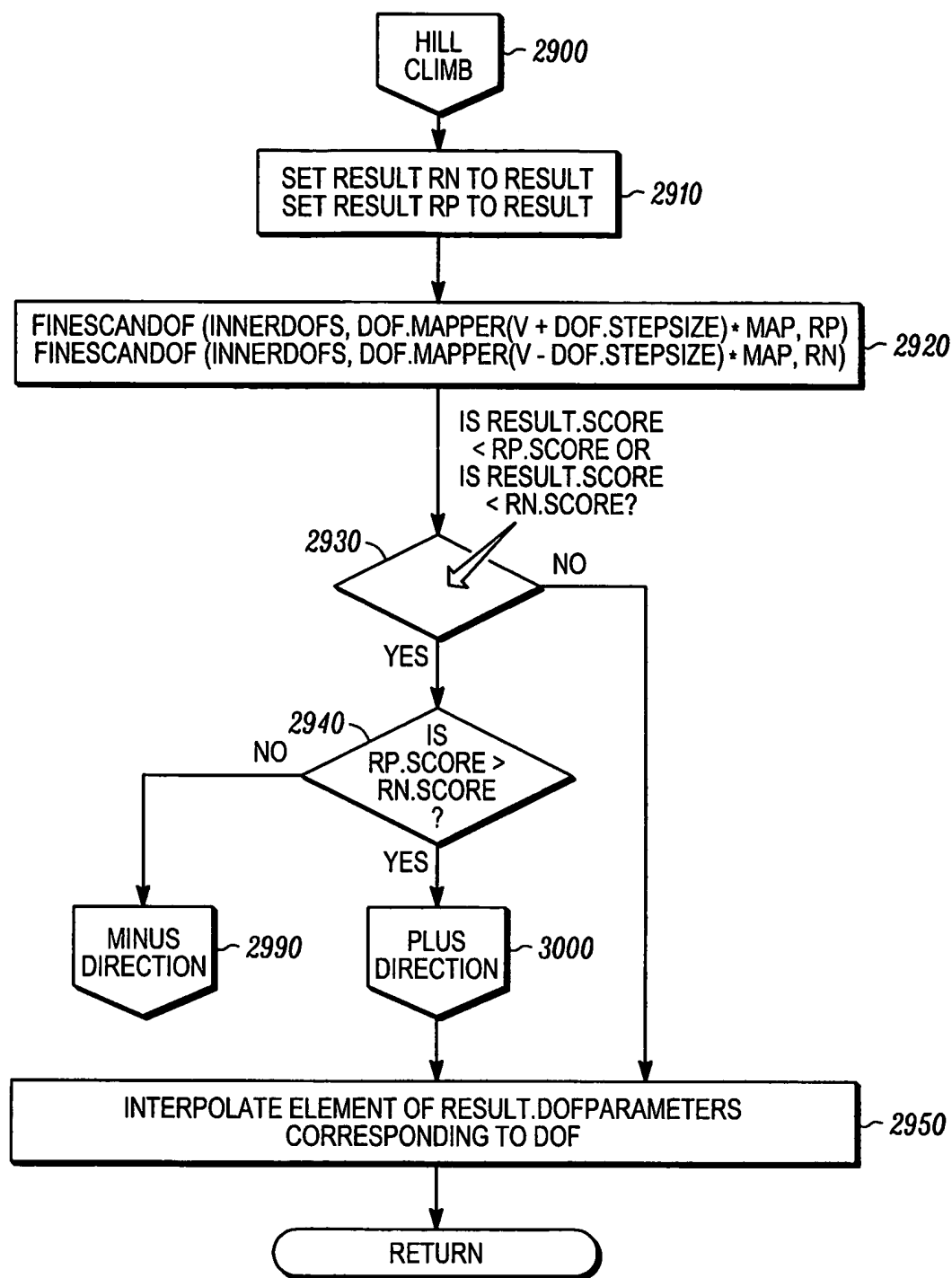


**FIG. 27**



**FIG. 28**

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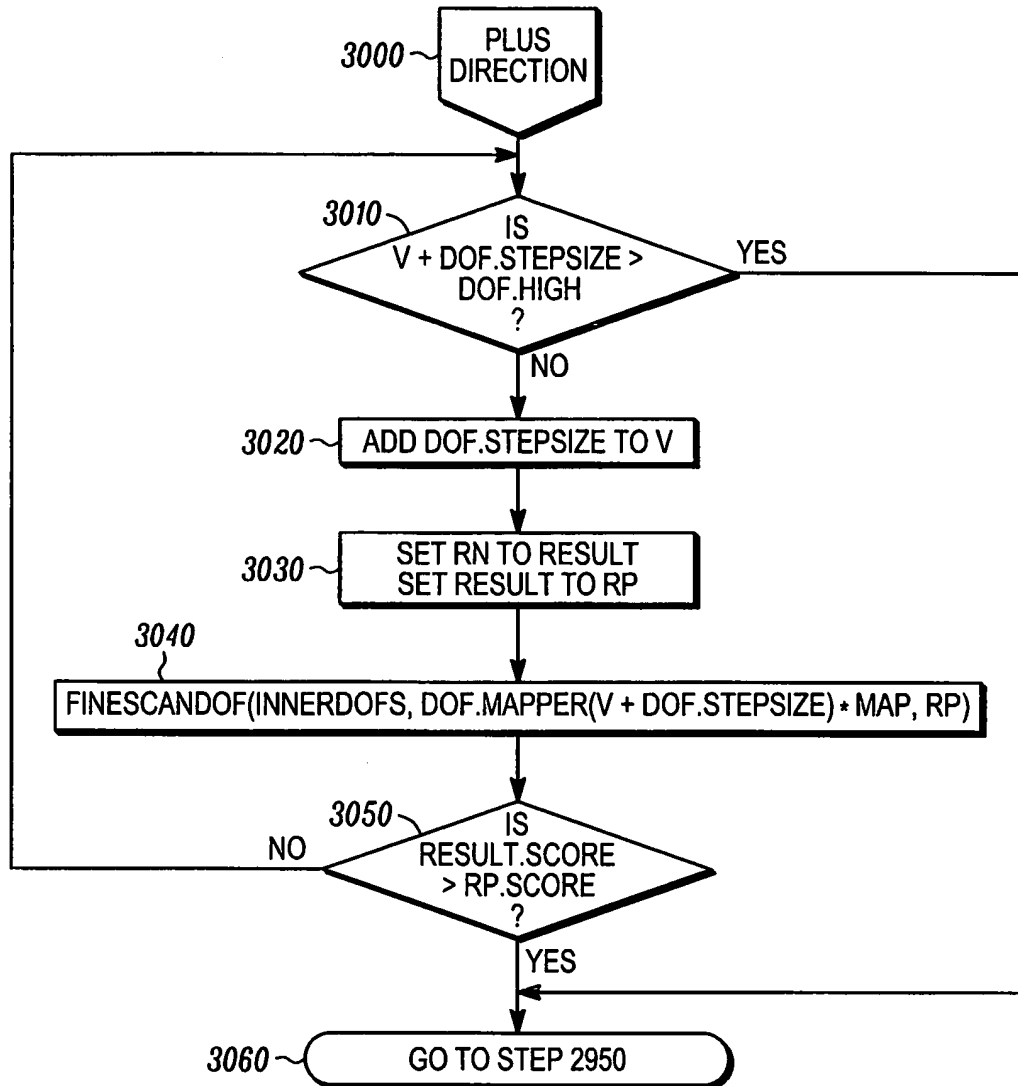


FINE SCAN HILL CLIMBING

FIG. 29



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FINE SCAN HILL CLIMBING, PLUS DIRECTION

FIG. 30

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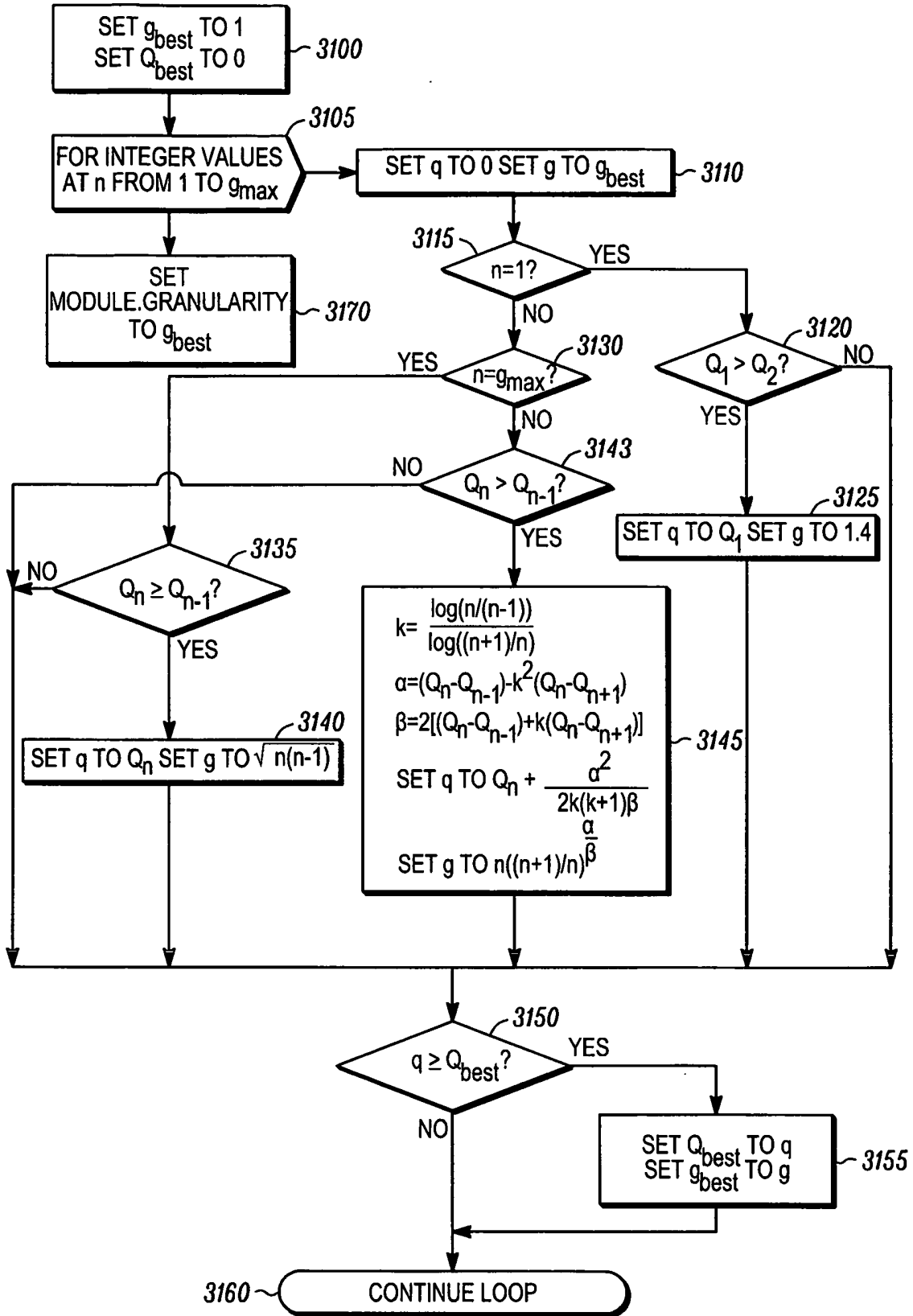


FIG. 31